CUBITUS VARUS; OR, "GUNSTOCK" DEFORMITY FOLLOWING FRACTURE OF THE LOWER END OF THE HUMERUS.[1]

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FRACTURE of the lower end of the humerus in some of its forms is not infrequently followed, especially in the young, by a conspicuous deformity of the limb known as cubitus varus or "gunstock" deformity. This deformity consists in marked permanent adduction of the forearm, which, of course, is most apparent when the elbow is in full extension. It is shown in Fig. 1.

FIG. 1.—Cubitus varus.

Clinically, the most prominent feature is the marked, apparently abrupt, movement made by the forearm towards the ulnar side as the limb approaches full extension, and the peculiarly ungraceful appearance of the limb in this position. Flexion, extension, and rotation are usually normal. The elbow viewed from behind shows the olecranon prominent

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and slightly displaced towards the inner side, flattening of the inner side of the elbow, and fulness of the outer side on flexion at a right angle with apparent enlargement of the external condyle below and behind.

On palpation, the external condyle appears to be thickened and lowered; the head of the radius rotates against an apparently normal capitellum; the internal epicondyle is less prominent than normal, and the mesial surface of the trochlea shows certain variations from the normal in its relations to the epitrochlea and the olecranon.

The immediate cause is a change in the relations of the transverse axis of the elbow-joint to the longitudinal axis of the humerus, a change by which its normal inclination, looking downward and outward, is changed to one looking downward and inward.

The question that most concerns us is the cause of this change in the direction of the transverse axis.

It has generally been attributed to an ascent of the internal condyle after its fracture, or, and less frequently, to a descent of the external condyle after its fracture. I am fortunately able to present several specimens and skiagrams which throw light upon the subject and indicate that the more frequent cause is probably supplied by other forms of injury which have only recently been associated with the deformity.

Before they are described, it must be noted that specimens showing the deformity due to undoubted fracture and ascent of the internal condyle (heretofore deemed, as I have said, almost the exclusive cause) are almost unknown.

The first specimen is one of low oblique fracture of the shaft without history (Fig. 2). The fracture evidently ran from the outer side at the junction of the lower and middle thirds downward and inward, probably terminating just above the internal epicondyle, and the fragment has united with an angular displacement, by which its upper end is carried half an inch away from the shaft, and the lowest part of the capitellum is brought down to the level of the lowest part of the inner edge of the trochlea; the fragment evidently turning
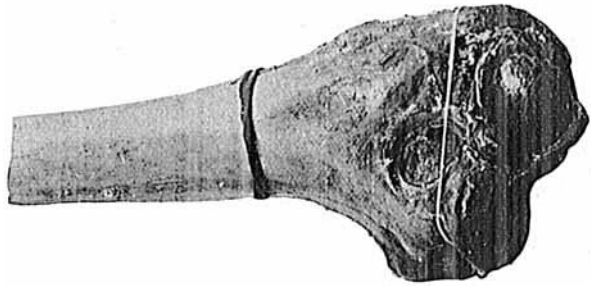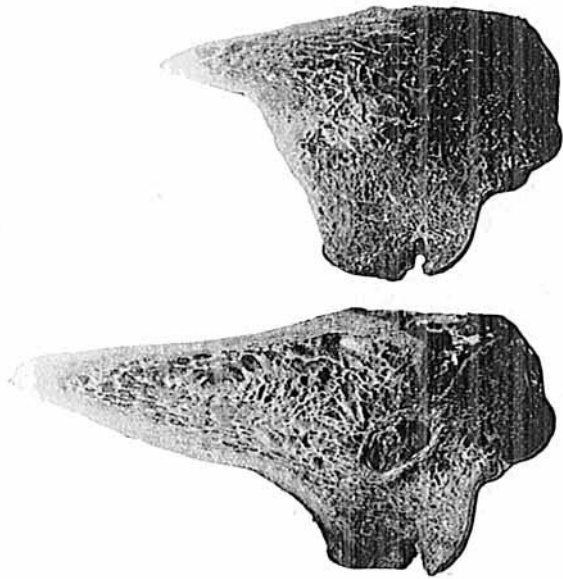
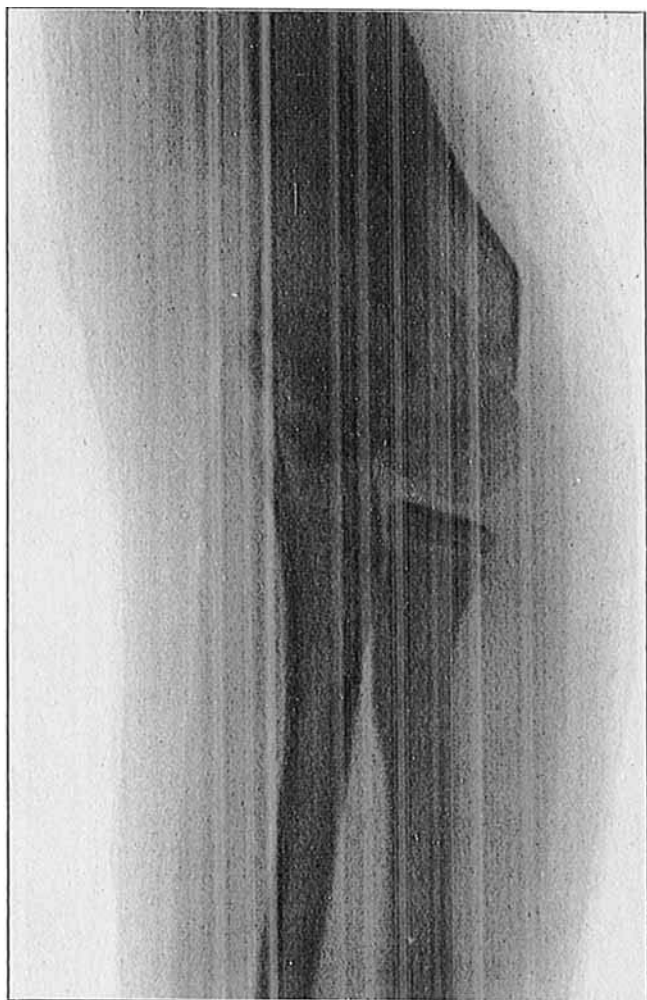Fig. 2.—Cubitus varus.

Fig. 4.—Cubitus varus.

FIG. 5.—Cubitus varus.

on its lower inner part as a pivot without other displacement on that side.

The second specimen, also without history (Fig. 3), shows a very marked deviation of the entire lower part of the bone; its transverse axis being so inclined that the lower part of the articular surface looks downward and inward at an angle of about forty-five degrees. The articular surface and the supracondylar ridges show no irregularity; but a fulness above the coronoid fossa strongly suggests a supracondyloid fracture with angular displacement (the angle open inward) of the fragment. The smoothness of the surface and the absence of marked irregularities could be explained, supposing the theory of the fracture to be correct, by its occurrence at an early age, the preservation of much of the encircling peri-osteum untorn, and the gradual obliteration by absorption of irregularities present at an early time.

Fig. 3.—Cubitus varus.

The third specimen (Fig. 4) shows a displacement practically identical with that of the second. The internal epicondyle and its ridge are apparently normal; the outer condyle is greatly lowered, the supinator ridge is lost, and the bone beneath is thickened and bent in an antero-posterior curve extending from well above the level of the coronoid fossa to the epicondyle, its convexity backward and its centre projecting so far behind the line of the shaft that the capitellum lies in that line instead of being far in front of it. The articular surface is smooth and unbroken except for a narrow notch between the capitellum and trochlea, which, however, is unaccompanied by any change in the relations of those two parts, but the trochlea is slightly deformed on the inner side, its edge being inclined inward instead of being vertical, and its central

groove is directed towards the outer side of the coronoid fossa. The appearance is as if the trochlea, with the external condyle, had been twisted upon the internal condyle, with lowering of the outer portion, so as to look downward and inward.

The specimen has been sawn twice in a frontal plane, the sections reaching the posterior surface of the bone at their upper end, and the surfaces of section (Fig. 4) show no trace of fracture. But it seems plain that the bone was broken on the outer side above the epicondyle, probably along the epiphyseal line at an early age.

The fourth specimen is shown by two skiagrams (Figs. 5 and 6). The patient, seven years old, injured the elbow by a fall from a pony. The injury was supposed to be a dislocation, and the limb was incased in plaster of Paris for three or four weeks. Two months later the skin over the external condyle became ulcerated by the pressure of the underlying bone, and the latter was freely cut away. I saw the case at that time in consultation. It was evident there had been a fracture passing close above the capitellum, and that the fragment had been displaced inward. The extent and direction of the line of fracture on the inner side could not then be determined.

The skiagrams were taken about three years later. They show detachment and depression of the capitellum, with preservation of its relations with the trochlea, and a twisting of the latter similar to that of the third specimen and a notable thickening posteriorly on the outer side similar to that of the same specimen of the skiagram of the next case. In examining the pictures it must be remembered that the outer portion of the external condyle has been removed.

Another skiagram, Case 5 (Fig. 7), shows the bones in the limb which furnished the photograph for Fig. 1. It was taken from a man twenty-eight years old, who had received his injury at the age of eight to ten years. The condition seems to be very similar to that of the third specimen. There is the same inclination of the unbroken articular surface; the same twist of the side of the trochlea towards its epicondyle; the same elongation of the outer side, and the same thick, bony
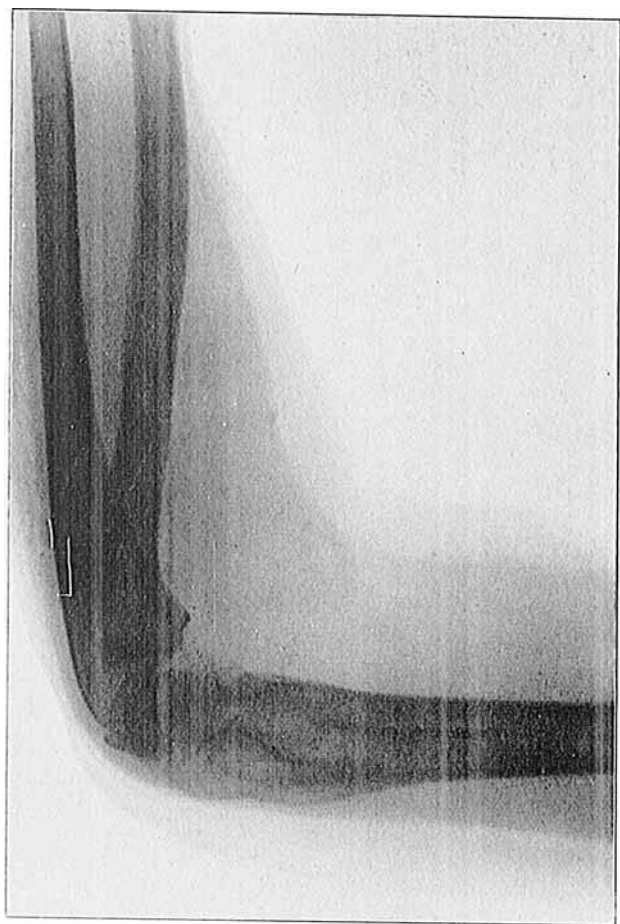
Fig. 6.—Cubitus varus.

FIG. 7.—Cubitus varus.

column running down to the external condyle, so far as can be judged from the pictures.

Another skiagram, of a case without history (6), shows similar conditions.

In all of these joints one point stands out prominently,—the unbroken line of the articular surface. That proves that the line of fracture did not extend through it; that the cause of the deviation of the axis of the joint is not the independent ascent of the internal condyle or descent of the external, but a twist of the entire articular process, independent of the internal epicondyle in some of them, including it in the others. In some of them, most of them, the entire external portion of the epiphysis, including its epicondyle, is notably depressed with a considerable development of new bone between it and the shaft from which it has been broken away; and in two (Specimen 3 and Case 5, skiagram) this new bone appears as a well-marked, rounded, slightly curved column on the exterior outer aspect of the bone.

It seems probable that the line of fracture in all of the cases passed above the external epicondyle, in one of them to have crossed the bone well above both epicondyles, in the others to have ended on the inner side at or near the lowest part of the internal epicondyle. In two cases (4 and 5) it appears to have detached the epiphysis in its entirety, with the exception of the internal epicondyle, and in one of them (4) with displacement inward.

Another point is that the displacement in all is angular, pivoting on the inner side just above or just below the internal epicondyle. It must be either primary—the result of, and indicating the direction of, the fracturing violence—or secondary, and the result of forces acting during repair.

In the absence of specimens of fresh injury, I have made a number of experiments upon young cadavers. In all the fracture was produced by forcible adduction of the extended forearm, a movement which should produce the angular displacement above mentioned. Two forms of fracture resulted. One was a pure supracondyloid wholly within the shaft; in the

other the line of fracture began on the outer side at or close above the junction of the shaft and epiphysis and passed inward, following the line of that junction wholly or in great part, but sometimes stopping before the inner surface of the bone was reached. In all the periosteum remained in great part untorn, although the adduction was carried nearly to ninety degrees; and in the lower fractures—the second form—the capitellum could be depressed as far as it is in the specimens and skiagrams, and yet retain a periosteal connection with the shaft that was wholly unbroken behind and on the side. Such conditions in the living, if the displacement was maintained, seem suitable for the production of the mass of new bone found in most of the cases shown. In the first form—the supracondyloid—the angular displacement was mainly produced by crushing on the inner side, sometimes without laceration of the periosteum at any point. That would probably insure in the living the smooth surface and unbroken outline of the second specimen, and tends to confirm the opinion that in it the fracture was supracondyloid. Therefore, while admitting that it is impossible to secure in an experiment upon the cadaver the co-operation of all the factors that may take part in the production of a fracture in the living, we can yet assume upon the findings of these experiments that a fracture can be produced in the young, along the indicated lines, which will produce primary displacement which, if not corrected, should result in the deformity of cubitus varus, as observed.

It remains to be ascertained if, in default of this primary displacement or after its correction, agencies may operate to bring about the same result. In the fourth case the patient was examined under ether by an experienced surgeon; the recognized displacement was thought to be a dislocation, and the limb was incased in plaster of Paris. When the dressing was removed about a month later the displacement was present, and was so marked that the skin over the lower part of the supinator ridge ulcerated under the pressure, and the bone protruded. It may fairly be assumed, I think, that the dis-

placement was corrected, but recurred either during the application of the dressing or subsequently. The only agency which could thus produce it is, I think, the unsupported weight of the limb. It is conceivable that the upper part of the forearm, being closely attached to the humerus only at its inner side, should tend to sink on its outer side by its weight alone, and thus draw down the outer part of the fragment while the patient was erect. And in supracondyloid fracture, if the limb was snugly supported by a sling under the elbow, the pressure of the support would be exerted through the olecranon and the internal condyle to push the latter upward, and thus effect the same change in the direction of the transverse axis of the joint.

I cannot escape the conclusion that such close resemblances in a chance collection of six cases, their easy experimental reproduction, and the almost total absence of specimens showing lesions of another kind, justify the belief that the common anatomical cause of cubitus varus is not ascent of the internal or descent of the external condyle after fracture extending into the joint, but that, on the contrary, it is an angular displacement of the entire lower end of the bone after a supracondyloid fracture, or of its lower portion after a fracture which is practically a partial separation of the cartilaginous epiphysis, especially at its outer side. The latter form of fracture seems to be possible only at an early age, not over ten or twelve years, because of the marked relative diminution in the size of the epiphysis as age increases. The epiphysis, which in the infant is a broad, thick, almost cylindrical mass of cartilage extending above both epicondyles and showing hardly a trace of the deep modelling of the articular surface seen in the adult, and giving attachment to ligaments and muscles by which a detaching strain can be exerted upon it through the forearm, gradually becomes relatively small and thin, until it is constituted on the outer side mainly by the projecting capitellum, and in its trochlear portion by a curved scale capping the rounded diaphysis, which not only offers no

purchase to a fracturing force, but can hardly be removed entire by knife or chisel.

Recognition of the displacement ought to be easy by attention to the level of the external epicondyle and head of the radius as compared with that of the internal epicondyle. Error might arise through mistaking the lower end of the supinator ridge for the external epicondyle, but it could be avoided by seeking the head of the radius and the adjoining edge of the capitellum. Comparison of skiagrams of profile views of displaced and normal bones brings out very clearly this lowering of the head of the radius.

Correction of the displacement could probably be easily made by pressure upward and outward against the olecranon in rectangular flexion of the joint, or abduction of the fully extended forearm, and maintenance of the latter position for a week or two would probably be the surest means of preventing recurrence, but it should be combined with confinement to the bed. I do not think full flexion of the joint, which has been recommended of late for the treatment of all forms of fracture in this region, could be trusted to correct the displacement or prevent recurrence, because, in all patients with the deformity whom I have seen, free flexion of the joint was possible. As the deformity does not prevent the attitude, the attitude cannot prevent the deformity.

If the convenient attitude of flexion at a right angle is chosen, and especially if the fracture is supracondyloid, pressure upward against the olecranon by a supporting sling must be carefully avoided, because such pressure would be transmitted to the inner half of the fragment, and would tend to produce the deviation which we seek to avoid. The sling should take the weight of the limb at the wrist.

In the other, the lower and, I believe, the common form of fracture, the rectangular position might be safely taken if incasement in plaster of Paris was used, and the upper portion of the dressing carried over the top of the shoulder so as to prevent its descent, which would permit, or perhaps even produce, recurrence of the displacement.